

## Monterey Bay National Marine Sanctuary Historical Ecology

### *Phase 1: Historical Sources Survey Report*

#### **Executive Summary**

*Historical ecological research is a way to document the environmental history of an area, providing information to resource managers, and ecologists that are trying to make sense of current trends occurring in altered ecosystems. However for scientists and historians trying to characterize historical baselines or gain insight into historical populations, it is important to gather historical information to assess what data are available before scientific questions can be asked. This report presents the results of a historic sources survey of documents and manuscripts relevant to NOAA's Monterey Bay National Marine Sanctuary (MBNMS) historical ecology. The initial research phase, as reported on here, provides methods on research and examines the breadth of these sources and their efficacy in providing information about the marine animal populations and environmental history of MBNMS. This report presents a summary of the hundreds of documents found in federal, state, and local repositories that relate directly or indirectly to the historical ecology of MBNMS and from which biological indicators of marine ecosystems may be derived.*

#### **Introduction**

The study of marine historical ecology can be a valuable tool for making informed regional conservation and management decisions. Historical studies provide an understanding of how current ecological conditions arose, identify modification or loss of habitat, help identify changes in species composition and abundance, and help in planning remediation projects (Pesch and Garber 2001). The need for these studies is important. Long-term sequences of decline in many marine ecosystems are largely unknown because knowledge of potential linkages and interdependence of the different responsible factors are often forgotten or ignored by new generations (Pandolfi, Bradbury et al. 2003). Populations of several marine species are far more depleted than realized because current conservation assessments do not reflect historic abundance data. We are all affected by the 'shifting baseline' phenomenon (Pauly 1995), i.e. man's perception of a "pristine" or "healthy" ecosystem relates only to experiences contained in a single lifetime using the state of a resource at the start of their lives as the baseline, rather than the resource before human exploitation. For this reason, many people believe that poorly-studied ocean ecosystems are thriving, when in truth, many face serious threats to their already compromised existence (Jackson 2001).

As ecologists continue to learn more about the marine environmental history the importance of incorporating this knowledge has grown. Ecological historical information such as historical narratives (e.g. anecdotal reports, photographs, paintings, journals, logs etc.), can serve as useful proxies to build a broad picture of historical ecosystems and help to establish unknown baselines. Ecosystem models that lack the accurate understanding of earlier conditions and the history of human impacts will arrive at bogus results and may lead environmental policy astray. Historical research can provide information on a variety of ecological processes including, specific animal populations relating to relative abundance, size, habitat, feeding behavior, and uses and trade by aboriginal and European human populations. These types of data provide clues regarding the degree of change that has occurred over time and can be useful in restoration policy, such as the Maryland and Virginia state government's massive restoration of oyster reefs and potential introduction of non-native oyster species in Chesapeake Bay, to attempt the amelioration of eutrophication, hypoxia, and toxic blooms. (Chesapeake Bay Program Chesapeake Action Plan 2000; Jackson, Kirby et al. 2001; Committee on Nonnative Oysters in the Chesapeake Bay National Research Council 2004). Although the scholarly records of marine life are limited and typically qualitative, using this research it is possible to gain records in a relatively accessible manner to at least the 1500s (Carlton 1998). These data are essential for management and restoration in ecologically and economically important communities in which the roots of degradation pre-date scientific data collection (Pandolfi, Bradbury et al. 2003).

Once historical perspectives are sought, the problems are principally methodological in nature. To build a picture of ecosystem state and function, archeological and zooarchaeological data are combined with historical records, narratives, and social science research. The scientific method, as practiced in the hard sciences, is useful for the rational investigation of repeatable phenomena. The marine historical ecologist

though, requires a basic knowledge of the historical content and context available and cannot ask good questions without understanding the facts, people, events, and systems within which the answer must be found (Anderson-Inman and Kessinger 2000).

Using recently conducted historical ecological work within MBNMS, a method is demonstrated for the collection and archiving of historical data that may serve as a model for extracting data about the historical ecology or environmental history of other marine sanctuaries and can facilitate future historical analyses as the first step of a study into the historical ecology of a marine ecosystem. In Phase 1 of the research project presented here, historical sources were identified and catalogued from which biological indicators on the marine ecosystems of MBNMS could be derived.

To date, over 300 sources have been found in federal, state, and local repositories that relate, directly or indirectly, to MBNMS marine ecology and resource use.

### Methods

A diverse range of historical documents was assembled that spanned more than 250 years; analysis of archeological data such as scientific reports expanded this range to encompass environmental data spanning millennia. The MBNMS study began with 3 goals: 1) to source historical material from which biological indicators on the marine ecosystems of MBNMS can be derived, 2) to digitize these data and to store these data in a database where it is accessible and 3) easily manipulated to serve as a resource for future historical analyses.

A historical context was first established for this project. The MBNMS is a specific marine area, however it is related to land-based activities and the ecosystems that surround it. Initially without a historical context to explain how or why marine populations have changed over time, biased interpretations and poor resource management or research decisions may result. This context was derived via multiple tools such as a basic internet search with simple keywords of “Monterey” and “History”. Once this was completed a group of search keywords that related to Monterey history were devised that could be used to mine online databases for relevant information. Using a combination of these initial keywords (*See Table (i)*) a bibliographic search of online catalogues (*See Table (ii)*) was conducted. This search resulted in more than 6,000 records of which approximately 350 were useful for historic descriptions of biological indicators within MBNMS.

<b>Search Terms</b>	
Marine history	Otter
Whale	Fur Trade
Whaling	Monterey
Carmel	Big Sur
Expedition	Voyage
Natural history	Abalone
Fishing	Santa Cruz

*Table (i), Catalogue of search terms used to mine archives*

<b>Catalogue</b>	<b>Web Address</b>
Online archive of California (OAC)	<a href="http://www.oac.cdlib.org/">http://www.oac.cdlib.org/</a>
MELVYL (Catalogue of the university of California libraries)	<a href="http://melvyl.cdlib.org/">http://melvyl.cdlib.org/</a>
Google	<a href="http://www.google.com/">http://www.google.com/</a>
Google Scholar	<a href="http://scholar.google.com/">http://scholar.google.com/</a>
Google Books	<a href="http://books.google.com">http://books.google.com</a>
SOCRATES (Catalogue for	<a href="http://jenson.stanford.edu/">http://jenson.stanford.edu/</a>

Stanford university)	
ARC (Catalogue for the National Archives)	<a href="http://www.archives.gov/research/arc/">http://www.archives.gov/research/arc/</a>
SIRIS (Catalogue for the Smithsonian Institution)	<a href="http://www.siris.si.edu/">http://www.siris.si.edu/</a>
JSTOR	<a href="http://www.jstor.org/">http://www.jstor.org/</a>
Internet Archive	<a href="http://www.archive.org">http://www.archive.org</a>
New York Times Archives	<a href="http://www.nytimes.com/ref/membercenter/nytarchive.html">http://www.nytimes.com/ref/membercenter/nytarchive.html</a>
NOAA Central Library	<a href="http://docs.lib.noaa.gov/rescue/Fish_Commission_Bulletins/data_rescue_fish_commission_bulletins.html">http://docs.lib.noaa.gov/rescue/Fish_Commission_Bulletins/data_rescue_fish_commission_bulletins.html</a>
NOAA Satellite and Information Service	<a href="http://map.ngdc.noaa.gov/website/mgg/nos_hydro/viewer.htm">http://map.ngdc.noaa.gov/website/mgg/nos_hydro/viewer.htm</a>
California Academy of Sciences Library	<a href="http://research.calacademy.org/research/library/">http://research.calacademy.org/research/library/</a>

Table (ii), Online archives and related websites

Records were sorted by data type as determined by (McClenachan and Jackson 2007). These data types are; *Scientific Reports and Journal Articles*, these represent statistical primarily peer reviewed reports and journal articles that involve research into historical, biological, or oceanographic elements for the MBNMS; *Maps and Charts*, these data are available from the early explorers in 1796 to modern biological surveys overlaid with California Department of Fish and Game (CDFG) navigational charts; *Early Exploration Narrative Accounts*, accounts are available throughout European historical exploration of the Pacific coast and provide some of the most vivid natural history descriptions. However care must be taken to triangulate sources and should be treated as dubious until verified; *Newspapers*, newspapers provide an accurate pulse for historical social stigmas, fishery catches and report rare events; *U.S. Fish Commission publications*, the bulletin of the United States Fish Commission is one of the oldest fisheries journals in the world. It has been an official publication of the U.S. Government since 1881, and is the U.S. counterpart to other highly regarded governmental fisheries science publications. It publishes original research or interpretative articles in all scientific fields that bear on marine fisheries and marine mammal science. The text is often written by fish commissioners and refers to the fish commission work in California and summaries of the industry; *Theses*, limited theses are available that provide useful secondary analysis, however theses have not been peer reviewed and analysis should be taken as opinion; *Photographs*, photographic documentation provides a rare visual window into history, however sources are only available from the late 19<sup>th</sup> century onwards.

Primary and secondary records and accounts were determined if they fulfilled Goal 1 of the study (*to source historical material from which biological indicators on the marine ecosystems of MBNMS can be derived*), and stored in a Filemaker Pro database including a description of data type (e.g., newspaper article, manuscript, photography etc.) unique code, title, date, author, search terms, and metadata files. Where applicable one metadata file was created for a group of records. Using these data, cultural periods were defined in terms of how people obtained and used marine resources as described by (Lotze, Lenihan et al. 2006). Earlier cultural periods were much longer than later periods (*See Table (iii)*). Housed, digitized records were sorted according to cultural periods in preparation for more detailed historical analysis.

<b>Cultural Period</b>		<b>Properties</b>
(i)	<i>Pre-European Native Americans (1500 – 1700 b.p.)</i>	Migratory peoples who are hunter and gatherer in nature, coastal resource use of in particular the inter-tidal zone occurred with limited offshore exploitation. Trade routes with inland groups established
(ii)	<i>Early European Exploration (1700 – 1800)</i>	Spread of western values, settlers establish missions and outposts, opening of sea-lanes and commencement of trade.

<b>(iii)</b>	<i>The Beginning of Commercial Fisheries / Commercial Marine Resource Use (1800 – 1900)</i>	People become centralized into large, metropolitan cities. Catch more than needed for own consumption, develop techniques for storage and transport, export surplus.
<b>(iv)</b>	<i>The Beginning of Industrial Fisheries (1900 – 1950)</i>	Distance no object; consumer preference starts to drive product development. Technological advances.

Table (iii), Cultural periods

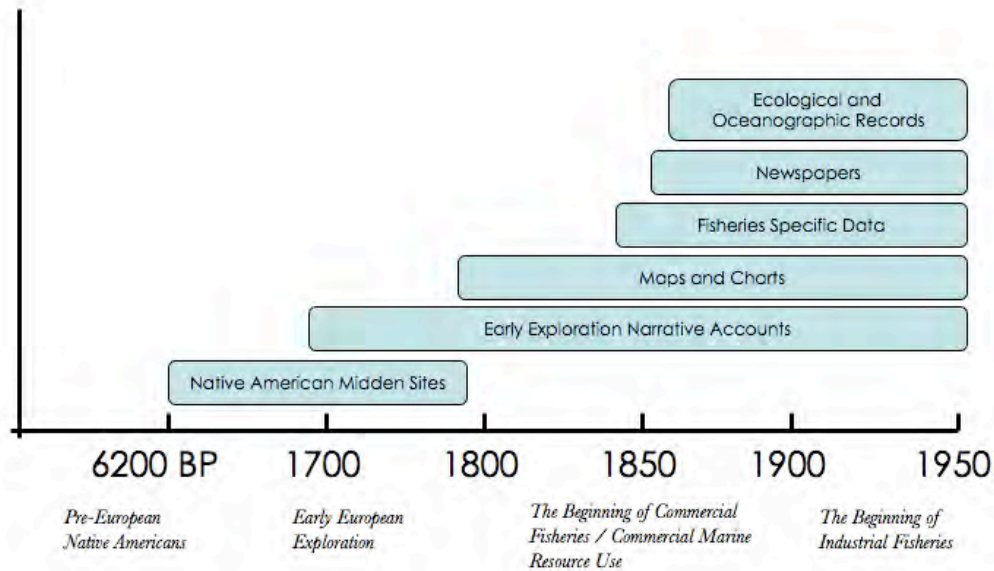


Fig 1. Timeline of primary source materials relevant to MBNMS

Where possible, sources that were obtained and appeared questionable were verified using an adaptation of the ‘triangulation method’, to support a finding by showing that independent measures of it agree with or at least do not contradict it to assess the source (Mills and Huberman 1994). This method was used to reduce bias as even in a primary source bias should be expected and corrected for by reading other versions, even if an event is not controversial it will have been seen and remembered from different angles of view by different observers.

When gathering new sources whenever possible, metadata records were compiled and stored to describe the source or record, where it was housed, limitations, and its authors. These data were stored with the record or group of records to facilitate further analysis.

**Results**

<b>Source</b>	<b>Date Range</b>	<b># Of Records *</b>	<b>Archives **</b>
Scientific Reports / Journal Articles ( <b>i, iv</b> )	8500 b.p. - 2003	20	Coyote Press (Gary Breschini, JSTOR)
Maps and Charts ( <b>ii – iii</b> )	1786 – 1950	25	Monterey Public Library, California History Room
Early Exploration Narrative Accounts ( <b>ii – iii</b> )	1602 – 1930	35	Google, Google Books, OAC
Newspapers ( <b>iii – iv</b> )	1850 – 1965	100	Internet Archive, New York Times Archives,

			Monterey Public Library, Santa Cruz Public Library
U.S. Fish Commission publications ( <b>iii - iv</b> )	1870 – 1903	25	NOAA Central Library
Fishery bulletins / Statistical records ( <b>iv</b> )	1913 – 1965	50	OAC, Google
Theses ( <b>iii - iv</b> )	1990	2	Monterey Public Library, OAC
Photographs ( <b>iii - iv</b> )	1870 – 1950	65	Monterey Public Library, Santa Cruz Public Library, OAC

Table (iv)

\* Numbers of records shown are approximate.

\*\* Lists only the main archives where these sources are available. Many of these sources can also be found in university libraries, historical society collections, and city and state libraries or archives.

Results will be displayed in the same format for each cultural period. A short historical overview of the relevant cultural period will be provided followed by notes on records relating to specific data types. These data types are listed as follows *Scientific Reports and Journal Articles, Maps and Charts, Early Exploration Narrative Accounts, Newspapers, U.S. Fish Commission publications, Theses, Photographs*. Where no data have been collected for a data type the term *n/a* for ‘not available’ will be used.

### ***Pre-European Native Americans, 1500 b.p.– 1650***

The central coast of California was inhabited by over forty different groups of indigenous peoples known collectively as the Ohlone who ranged from Point Sur to the San Francisco Bay. Evidence suggests that the earliest human occupancy of the California coast was 8,000 b.p. with immigrants who were primarily hunters, and that a strong dependence on shoreline resources and seed gathering, developed some time later, about 5,500 b.p. (Meighan 1965). Subsistence was based on hunting and gathering. Food preferences were divided between coastal and more inland groups in general, although there were several universal foods, which included acorn, shellfish, salmon, deer, waterfowl, seeds, roots, and greens (Ryan 1980). The Ohlone followed a semi-nomadic lifestyle by moving to different camps within their territory to make use of seasonally available food in coastal and inland areas and were a part of an intricate trade network that connected the eastern Sierra Nevada, Sonoma County, and Santa Barbara. Outgoing trade goods included coastal shell, salt, and dried abalone meat and anything that the area lacked, they traded for (Cartier, Crane et al. 1991). The coastal dwellers made use predominantly of the intertidal zone collecting shellfish, sea urchin, mussels, and marine mammals such as sea otter and pinnipeds. They fished constantly, using nets, harpoons, basket traps, hooks, and even fish poisons and were very adept at fishing from rafts made of reeds. Salmon (*Oncorhynchus* sp.) were seasonally abundant and were a major food item to the Ohlone; living on the coast or near rivers and streams, they had a good understanding of fishing seasons to the point where they would regulate catch at certain times of year (Thomas, personal communication, 2008).

#### *Scientific Reports and Journal Articles*

The California central coast has numerous coastal middens (areas of domestic waste) many of which have been excavated with relating archeological reports available. These records are useful to document principle marine resources that were used by the coastal people. There are limitations to these data. Midden research is a study into refuse and can provide skewed results, for example misinforming resource use. Rare midden finds, captured because of ecological phenomena or opportunistic hunting and gathering, such as whale remains, can present a confounded picture of what was typically available and used by these people. These archaeological reports are available for many previously investigated central coast middens that lie within the bounds of MBNMS (Fig 2.). These reports are available from Archeological Consulting headed by Gary

Breschini who has done much of the work in the region. In addition, regional scientists most notably at University of California, Santa Cruz, have attempted limited analysis of existing data.

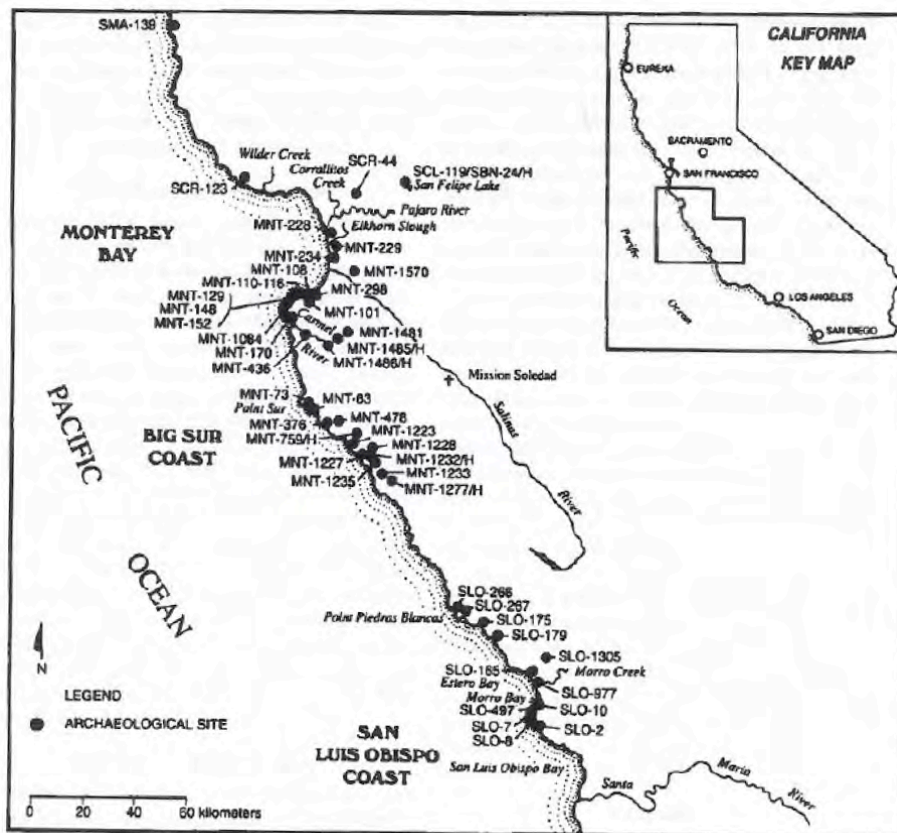


Fig 2. Location of archaeological sites on the central California coast. (Gobalet and Jones 1995)

*Maps and Charts (n/a)*

*Early Exploration Narrative Accounts (n/a)*

*Newspapers (n/a)*

*U.S. Fish Commission publications (n/a)*

*Theses (n/a)*

*Photographs (n/a)*

### **Early European Exploration, 1650 – 1795**

In 1602, Sebastian Vizcaino, leading a fleet that consisted of the ships *San Diego*, *Santo Tomas*, and the frigate *Tres Reyes*, sailed by Carmel Bay and rounded the Punta de los Pinos (Point Pinos) entering the harbor. He named the harbor after the viceroy of Mexico, Don Gaspar de Zuniga y Acevedo, then Count of Monte Rey whom had dispatched the expedition (Bancroft 1884).

These were the first known European explorers to reach the bay although in 1542 Juan Rodriguez Cabrillo is thought to have sailed through Monterey Bay describing an area called ‘Bahia de los Pinos’ and ‘Cabo de Pinos’ most likely Monterey Bay and Point Pinos. The Spaniards set up a network of missions along the California coast and lived a largely subsistence lifestyle farming and raising cattle. They came mainly from cattle dominated areas in Mexico and as such rarely took marine resources such as fish and made few boats (Simpson 1930).

*Maps and Charts*

There are two maps of Monterey Bay from this period, from Jean-François de Galaup comte de La Pérouse

during his round the world voyage in 1785, 1786, 1787, 1788 (he visited Monterey in 1786) and Don Miguel de Costanzo, an engineer in the overland party commanded by Don Gaspar de Portola in 1790. La Pérouse's map is an early printed plan of Monterey Bay, said to have been drawn by some of La Pérouse's officers (Wagner 1937). Costanzo's map saw the first recorded soundings to represent the bathymetry of Monterey Bay although only 17 soundings were taken.

#### *Early Exploration Narrative Accounts*

First person narratives dominate the documents from early European exploration. These accounts provide qualitative documentation of the region's varied and abundant marine resources prior to intensive commercial exploitation. Early published accounts include Miguel Venegas (1759), Pedro Fages (1770), La Perouse (1786), and Tomas de Suria, chief scientist of the expedition commanded by Alessandro Malaspina, (1791). There are secondary sources that review documents from this time period that focus on marine resource use, the sea otter trade in particular. Most documents are available online via Google Books, JSTOR or can be found at the Monterey Public Library.

*Scientific Reports and Journal Articles (n/a)*

*Newspapers (n/a)*

*U.S. Fish Commission publications (n/a)*

*Theses (n/a)*

*Photographs (n/a)*

#### ***The Beginning of Commercial Fisheries / Commercial Marine Resource Use, 1795 – 1900***

This period commenced the first targeted commercial exploitation of marine species on the west coast of America characterized by the harvest of marine animals, initially for commercial products such as furs and oil. The principal items were sea otter, fur seal, sea lion, and whale (Evermann 1923). The surrounding trade had the effect of drawing many settlers to California during this time, similar to the California gold rush, which only served to increase pressure on environmental resources. Abalone and mussels had been fished by the native Americans for thousands of years, and by the Spanish for their shells to trade for otter skins in the Pacific northwest and to make lime for use in mortar (Leechman 1942). These species were commercially fished in the latter part of the 19<sup>th</sup> century by the Chinese after they settled the central California coast in 1853 (Lydon 1985). Shore whaling, a major industry after the fur trade also began around this time and had dedicated shore whaling stations in Half Moon Bay, Pigeon Point, Davenport, Santa Cruz, Moss Landing, Carmel, Point Lobos, and San Simeon; by 1861, Monterey was described as a great whaling port along with San Francisco on the west coast (Starks 1923).

The latter part of this period saw a more generalized use of marine resources, in particular by the Chinese who caught a wide variety of marine life, to be dried and then shipped to China. Often these products such as abalone, squid, and sea weed were unknown to the American settlers but by virtue of their differences they caused social rifts, particularly because of the odors created from such large scale drying operations and accusations of overfishing by protectionist Italian and Portuguese fishers (Chiang 2004).

#### *Scientific Reports and Journal Articles*

Modern scientific reports and journals are limited from this time period with the majority of work being analysis of documented events or research into primary sources, such as Adele Ogden's work regarding the sea otter fur trade. There are scientific papers from the latter half of the 19<sup>th</sup> century most notably from Capt. C.M. Scammon, a former whaler that wrote extensively on the biology and habits of cetaceans, and other marine mammals including pinnipeds and sea otter. These papers are mostly found through online archives such as JSTOR, Google Books, and through the Monterey Public Library's, California History Room.

#### *Maps and Charts*

During this period, exploration occurred rapidly from the pursuit of marine resources such as sea otter and Atlantic whalers entering the rich whaling grounds of the Pacific. Maps of the Monterey region and the area

encompassing the MBNMS from this time period exist from a variety of different sources that enable triangulation. At this time, Monterey was the capital of Alta California and as a result its harbor and the bay was surveyed more intensively than much of the surrounding area that has led to the preservation of navigation data such as bathymetry and kelp boundaries.

#### *Early Exploration Narrative Accounts*

Many of the first person narratives from this period are journals of fur traders and fishers in this region that describe the natural resources that they found, the subsequent exploitation methods, and provide social commentary on treatment of aboriginal peoples and the governmental structure. These sources include explorer accounts such as Russian commander Otto Von Kotzebue (1821) and Capt. F.W. Beechey (1826) although there are a number from less well known California settlers as well that can be found through internet search engines, particularly at the "California as I Saw It:" First-Person Narratives of California's Early Years, 1849-1900 website (*Table (ii)*).

#### *Newspapers*

Prior to 1900, newspapers often detailed information such as dates of arrivals and departures. In the case of shore whaling stations, newspapers would often detail, size, species, and potential oil value of whales. The newspapers mention rare occurrences such as “whale stranding” and “rare or large fish caught” and are a good barometer for broader social issues towards the ocean and fishing.

#### *U.S. Fish Commission publications*

During this period, publications in the bulletin of the U.S. Fish Commission were typically conjoined into ‘Pacific Coast’ Fisheries, and as they developed in later reports more in depth reports were written. George Brown Goode, then commissioner of the U.S. Fish Commission also wrote a 5-part summary of the fisheries of the U.S. in 1887 and contains detailed information about fishers, methods, and species of the Pacific coast.

#### *Photographs*

Photography became a tool around the late 19<sup>th</sup> century and there are many photos that capture methods and scale of marine resource use e.g. Chinese fishing for squid and abalone. Primary repositories for information are the Monterey Public Library’s California History Room, Monterey Maritime History Museum and the California Views ([www.caviews.com](http://www.caviews.com)) owned by Pat Hathaway.

#### *Theses (n/a)*

### ***The Beginning of Industrial Fisheries, 1900 – 1950***

The start of industrial fisheries showed a move from marine exploitation for goods such as oil and fur to marine exploitation almost exclusively for food. Technological advances, most notably the change in propulsion for fishing vessels from sails to engines allowed for a greater fishing effort no longer constrained by wind and tide. New gear such as the lampara nets and purse seines enabled fishers to target entire schools rather than individuals by rod and line. This is illustrated best by Monterey’s sardine fishery that began in 1903 with the establishment of a sardine packing plant (Scofield 1929). Bottom trawls like the paranzella, first introduced in San Francisco Bay, 1876 (Scholz, Steinback et al. 2003), have had an effect on the benthic habitat of the MBNMS most likely removing invertebrate organisms and corals creating a more uniform sea floor dominated by sediment (Roberts 2007).

As technological advances were made, dwindling numbers of many species that had been harvested for decades were quickly fished until uneconomically viable. Charles M. Scammon (1874) stated, referring to shore whaling, "This peculiar branch of whaling is rapidly dying out, owing to the scarcity of the animals which now visit the coast; and even these have become exceedingly difficult to approach." Whaling however was continued beyond this, as it was still profitable. Edwin Starks (1923) stated, “First: Whaling is so destructive and certain by the present methods that when the gunner of a steam whaler has a fair chance at a whale it is as good as secured. Second: Every part of the whale is used, and the demand for the various

products of fertilizer and chicken feed is so good that the part of the whale that was once cast adrift as worthless is now about as valuable as the oil.” This intensive use saw whale populations fall to such levels they are only to beginning to recover after the International Whaling Commission (IWC) imposed a moratorium of catches in 1986.

Legislative protection emerged during this period such as the 1911 international fur trade ban to conserve falling numbers of economically important species like fur seals (Stanley-Brown 1893); it also provided a much needed respite to sea otter hunting in northwest America and paved the way for their re-colonization of the otter back to the California coast. Restraint whether imposed by the supposed extinction of the sea otter or through legislation allowed populations of pinnipeds and otter to rebound re-entering already drastically changed ecosystems.

The newly established CDFG led scientific monitoring using the pink ticket system and these data paved the way for modern fisheries catch data that start around 1913. Many of the statistics were derived from the ‘pink tickets’, a system that required each person buying fish from a fisherman recorded the purchase in triplicate on forms (tickets) furnished by the state; the first copy going to the fisherman as a receipt, the second used by the purchaser for posting in his own books, and the third (pink ticket) given to the state as an official document showing the date, locality, purchaser, fisherman, fishing boat, pounds weight of each species caught, price and use to which the fish is put. Due to this system extremely detailed data exists from 1930. Limitations in monitoring data collection occurred over times of social change e.g. during world war II the staff of the Bureau of Marine Fisheries was limited and although the statistical program within the CDFG was maintained it was only possible to follow the trends in major fisheries.

#### *Scientific Reports and Journal Articles*

Scientific monitoring increased during this period, particularly for economically important species principally due to the ‘pink ticket system’ conducted by CDFG, the National Marine Fisheries Service, and local universities. These results allowed for the basis for boat catch analysis to determine the presence or absence of overfishing in many of the CDFG Fish Bulletins, but such questions were not involved in the consideration of total catch figures (Bureau of Commerical Fisheries 1928). These reports can be found in JSTOR or the OAC and are freely downloadable.

#### *Maps and Charts*

Charts from this period became much more accurate and regular surveys by the U.S. Coast and Geodetic commission uncovered previously unknown geological features such as Davidson Seamount. Many hydrographic sheets or ‘H’ Sheets are surveys that the State Lands Commission is in the process or has already digitized and are available in an Arc Viewer at the NOAA Satellite and Information Service (*appendix b*) although they are physically housed at their repository in Sacramento. One series of charts was created by the U.S. Department of Fish and Wildlife in the 1960s that illustrates kelp habitat and biological species most likely to occur in an area and denote kelp habitat.

#### *Early Exploration Narrative Accounts*

Although by this period much of the terrestrial area adjacent to the MBNMS had been settled, there are still relevant accounts relating to resource use or eyewitness accounts, and references to the biological communities such as kelp that may not have been monitored by governmental agencies. There are memoirs of participants in the *early European exploration* cultural period that provide insight into methods of resource extraction and production.

#### *Newspapers*

Newspapers from this period contain interest pieces and inform the local opinion regarding marine issues such as otters destroying commercial abalone beds and plans to harvest kelp. There are reports of rare species and abnormal events such as the second ever landing of pelagic red crabs in Monterey Bay (the first being in 1859). There is an extensive archive of local papers both at the Monterey Public Library’s, California History

Room, and the Santa Cruz Public Library.

#### *U.S. Fish Commission publications*

The U.S. Bureau of Fisheries that was later made into the Fish and Wildlife Commission and the National Marine Fisheries Service replaced the U.S. Fish Commission in 1902. There are numerous reports that increase as scientific solutions to resource extraction problems became more prominent during the 20<sup>th</sup> century. They can be found through JSTOR and other online archive summaries.

#### *Theses*

There are limited theses but are useful analyses of primary sources within the MBNMS.

#### *Photographs*

Photography became widely available around the late 19<sup>th</sup> century and there are many photos that capture methods and scale of marine resource use e.g. sardine and salmon fishing boats, abalone diving operation and rare species caught. Primary repositories for information are the Monterey Public Library's California History Room, Monterey Maritime History Museum, and the California Views ([www.caviews.com](http://www.caviews.com)).

### **Discussion and Conclusions**

As state capital under both Spanish and Mexican rule, Monterey is one of the best places on the west coast of America to obtain qualitative and quantitative records that relate to marine ecological history of an area. Monterey Bay and MBNMS is an area of great productivity due to the California Current driven upwelling ecosystem and related fisheries. However, although exploitation and degradation began millennia ago, no attempt has been made to characterize the changes.

These methods have revealed a wide diversity of historical sources that pertain to the marine historical ecology of the MBNMS. As expected, the defined cultural periods yielded different numbers of historical sources from a variety of avenues, from archaeology to popular newspapers. Historical sources although available through a number of different institutions raise challenges as there is very little previous research that has been conducted to validate these data sources. Triangulation can be useful in adding transparency and reproducibility to historical reconstruction attempts, however as there is a dearth of historical data particularly from the early 19<sup>th</sup> and 17<sup>th</sup> and 18<sup>th</sup> centuries, this method is challenging and many sources must be taken at face value.

Based on the review of available historical sources there are several records that can be used for further analysis to inform ecological change. This determination is based on the condition and integrity of the records, and their potential to yield information about species populations, changes affecting the populations, composition, distribution, and diversity within MBNMS and Monterey. In addition, these records go into the social, cultural, and economic consequences of over-exploitation, pollution, and government regulation of marine resources. These sources help to build a historic context that will bridge observations of the marine environment made in the 17<sup>th</sup> century to the collection of fisheries data made in the late 19<sup>th</sup> and early 20<sup>th</sup> centuries.

The restoration and conservation of the MBNMS marine habitats and species populations in intensively managed and utilized marine areas involve many competing demands for those same areas. The use of historical records is important to establish both the productivity of past ecosystems, to understand what we have lost, and to characterize ecological change. These products are useful for informing current policy e.g. restoring historical productivity or water quality by the reintroduction or increased management of key species or managing rebounding populations of marine species that are re-entering changed ecosystems such as sea otter impact on shellfish fisheries.

**Future Research**

Combining existing historical research such as archaeological and zooarchaeological data to recently discovered western historical data allows us to assess human impacts from ancient marine ecosystems to the present day and extend the ecological baseline of the MBNMS further towards a pristine state. Future work using this collected data is to map trends of observed abundance within the MBNMS over time, and to create an older historical baseline of marine biodiversity and abundance. These objectives can be met by mining gathered data for anecdotal evidence of biological indicators that are sorted using a multi level abundance coding system (Pandolfi, Bradbury et al. 2003; Palomares, Mohammed et al. 2005) to gather quantitative information on marine organisms from qualitative sources such as historical narratives. Further investigation into historical data, relating to, climatic and oceanographic variables, specific species and their ecological role could be instrumental in understanding the relationships between human modified resources and pristine biomass stocks, providing key information that would impact resource management decisions, and when presented to an audience a powerful conservation incentive to protect the local marine ecosystem.

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